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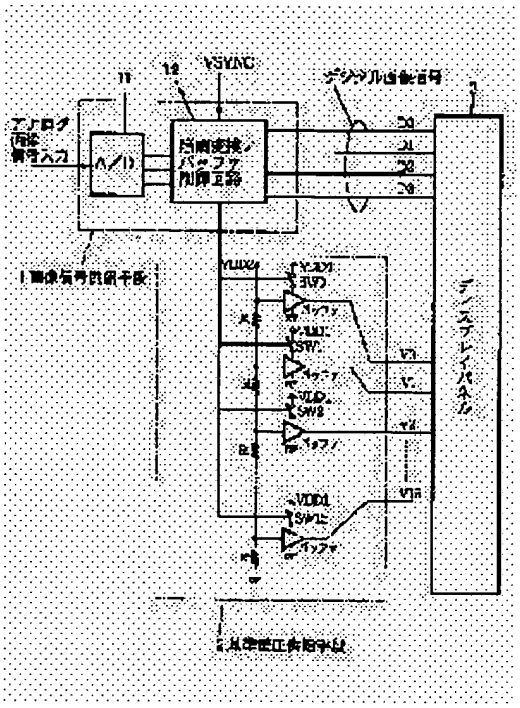
(54) DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To reduce power consumption of a device by adaptively adjusting the number of gradations in accordance with a picture signal input.

SOLUTION: This device is provided with a picture signal supplying means 1, a reference voltage supplying means 2 and a display panel 3. The picture signal supplying mean 1 supplies multi-level digital picture signals (D0, D1, D2, D3) to be expressed with prescribed bits. The reference voltage generating means 2 generates plural reference voltages (V0-V15) corresponding to respective gradations and also outputs them via buffers provided for every gradation. The display panel 3 is provided with pixels arranged in a matrix and also specifies gradations assigned for every gradation based on the digital picture signals (D0, D1, D2, D3). Moreover, the panel 3 projects displays by impressing reference voltages (V0-V15) corresponding to the specified gradations on respective pixels. The picture signal supplying means 1 is provided with a gradation/ buffer control circuit 12 and supplies the picture signals to the panel 3 by lowering the number of gradations according to the content of a display and also stops operations of buffers corresponding to omitted gradations by controlling the reference voltage supplying means 2.



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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a display. It is related with the low-power-ized technique of the display which can perform a gradation expression based on a digital picture signal in more detail.
[0002]
[Description of the Prior Art] Drawing 3 is the typical block diagram showing the conventional indicating equipment. This indicating equipment is equipped with the picture signal supply means, the reference voltage supply means, and the display panel. A picture signal supply means consists of an analog-to-digital converter (A/D) 11, quantizes an analog picture signal, and changes it into the digital picture signal (digital data) of many gradation expressed with the predetermined number of bits. In the example of illustration, digital data are 4 bit patterns of D0-D4, and can perform the image expression of 24 = 16 gradation. Including the resistance R by which series connection was carried out, a reference voltage supply means carries out resistance division of the supply voltage VDD2, and generates the reference voltages V0-V15 of 16 pieces corresponding to each gradation. This reference voltage supply means outputs each reference voltages V0-V15 through the buffer formed for every gradation. A buffer is a voltage stabilizer (electrical-potential-difference stabilization circuit) which operates in response to supply of the predetermined electrical potential difference VDD1, was not concerned with fluctuation of an output load, but is equipped with the capacity which can supply fixed reference voltage. A display panel 3 specifies the gradation assigned for every pixel based on the digital data D0-D3 supplied from A/D11 while being equipped with the pixel by which matrix arrangement was carried out. Furthermore, the reference voltages V0-V15 corresponding to the specified gradation are impressed to each pixel, and the display of a multi-gradation expression is copied out.
[0003] Drawing 4 is front drawing showing the correspondence relation between the digital data of a 4-bit (D0, D1, D2, D3) parallel configuration, and reference voltages V0-V15. When the digital data (D0, D1, D2, D3) assigned to a certain pixel takes the value of (1, 1, 1, 1), the reference voltage V0 of the high end is impressed to the pixel concerned. When a display panel 3 performs a monochrome display by the normally white mode, the pixel concerned presents black by impression of the reference voltage V0 of the high end. Moreover, when digital data (D0, D1, D2, D3) takes the value of (0, 0, 0, 0), the reference voltage V15 like the minimum is impressed to a pixel, and white is presented. When the values of digital data (D0, D1, D2, D3) are (1, 0, 0, 0), the almost middle reference voltage V7 is impressed, and a pixel presents almost middle gray. Thus, a display panel 3 gives the lightness which was missing from white from black according to the value of the digital data of 4 bit-parallel configurations, and was divided into 16 gradation to a pixel.
[0004]
[Problem(s) to be Solved by the Invention] According to the digital data of 4 bit patterns, the number of display gradation is 16, and the reference voltage of 16 level is required of the conventional example mentioned above. 16 buffers are prepared for the reference voltage supply means according to this. In the case of the digital data of 8 bit patterns, the number of display gradation becomes with 28 = 64, and the reference voltage of 64 level is required. According to this, 64 buffers will be formed in a reference voltage supply means. Thus, it is necessary to increase the number of input levels of reference voltage in the indicating equipment of the conventional digital input according to the number of display gradation. For this reason, the number of the buffer which supplies each reference voltage will also increase, and power consumption will also increase. Each buffer is performing electrical-potential-difference stabilization actuation in response to supply of the fixed electrical potential difference VDD1, and the bias current is always flowing.
[0005] By the way, when using the indicating equipment mentioned above as an output device of portable information

devices, such as a note type personal computer, various images copy out on a display panel according to the class of application, and it is going across the contents of a display variably. For example, when a portable information device is used as a word processor, an alphabetic character will mainly copy out on a display panel, and display gradation will be concentrated on 2 level of black and white. Moreover, when it uses as a game machine, the graphic which included halftone to some extent copies out in many cases. Furthermore, when using for the playback or processing of a photograph photoed with the digital camera, the image accompanied by a various and complicated gradation change copies out on a display panel in many cases. However, in the conventional display, it is not concerned with the contents of the image, but the firm gas of the reference voltage corresponding to all gradation is carried out, and great power was consumed that much with each buffer. Although there is unnecessary gradation level depending on the contents of a display, in order to supply all reference voltages as initialization, unnecessary power was sometimes consumed plentifully. Especially this led to shortening of the life of a built-in cell, when using for the output device of portable information devices, such as a note type personal computer, and it had become the technical problem which should be solved.

[0006]

[Means for Solving the Problem] The following means were provided in order to solve the technical problem of a Prior art mentioned above. That is, the indicating equipment concerning this invention is equipped with the picture signal supply means, the reference voltage supply means, and the display panel as a fundamental configuration. A picture signal supply means supplies the digital picture signal of many gradation expressed with the predetermined number of bits. A reference voltage supply means is outputted through the buffer which generated two or more reference voltages corresponding to each gradation, and was formed for every gradation. A display panel specifies the gradation assigned for every pixel based on this digital picture signal while being equipped with the pixel by which matrix arrangement was carried out, it impresses the reference voltage corresponding to this gradation to each pixel, and copies out a display. As a description matter, said picture signal supply means suspends actuation of the buffer corresponding to the gradation which controlled this reference voltage supply means and was excluded while it drops the number of gradation of this digital picture signal according to the contents of the display and supplies it to this panel.

[0007] For example, when the contents of the display present change of comparatively complicated gradation, while said picture signal supply means maintains the many gradation set up in first stage, when the contents of the display present change of comparatively simple gradation, it drops gradation. Or while said picture signal supply means maintains the gradation set up in first stage according to the gradation distribution showing the contents of the display as for the range where manifestation frequency is comparatively high, as for the range where manifestation frequency is comparatively low, gradation is dropped partially.

[0008] Usually, the number of reference voltages inputted into a display panel increases, so that the display panel of a digital input becomes many gradation, and the power consumption of a buffer which drives a load increases. In this invention, by reducing display gradation according to the contents of the digital picture signal, actuation of the buffer corresponding to the reference voltage hardly used is suspended, and low-power-ization of the whole system is attained. For example, it changes into gradation fewer than the initialized many gradation according to the inputted digital picture signal. By stopping completely the buffer of the gradation which is not used, a part for the power which the stopped buffer consumed can be reduced. Or according to gradation distribution of the inputted digital picture signal, little [manifestation frequency] gradation is deleted relatively. By stopping completely the buffer of the gradation which will be used by deletion, a part for the power which the stopped buffer consumed can be reduced. Thus, in this invention, by adjusting the number of display gradation accommodative depending on an input signal, it becomes possible to control actuation of an unnecessary buffer, without degrading image quality on parenchyma, and low-power-ization of the whole system can be attained.

[0009]

[Embodiment of the Invention] With reference to a drawing, the gestalt of operation of this invention is explained to a detail below. Drawing 1 is the typical block diagram showing the gestalt of operation of the indicating equipment concerning this invention. This indicating equipment is equipped with the picture signal supply means 1, the reference voltage supply means 2, and the display panel 3 as a fundamental configuration so that it may illustrate. The picture signal supply means 1 supplies the digital picture signal of many gradation expressed with the predetermined number of bits to a display panel 3. With this operation gestalt, the digital data of 16 gradation expressed with 4 bits of D0-D3 is supplied to the display panel 3. In addition, this invention is not restricted to this and you may make it supply the digital data of 64 gradation or 256 gradation. The effectiveness of this invention becomes remarkable, so that the number of gradation increases. With this operation gestalt, the picture signal supply means 1 contains the analog-to-digital converter 11, and has changed into the digital picture signal the analog picture signal inputted from the outside.

However, this invention may be a method which is not restricted to this, generates a digital picture signal within a system, and supplies this to the direct display panel 3. The reference voltage supply means 2 includes the resistance R by which series connection was carried out, carries out resistance division of the supply voltage VDD2, and generates the reference voltages V0-V15 of 16 level corresponding to each gradation. The reference voltage supply means 2 outputs each reference voltage V0-V15 to a display-panel 3 side through the buffer connected to the end of each resistance R. Each buffer is operating in response to supply of the fixed electrical potential difference VDD1. In addition, switches SW0-SW15 are attached in each buffer, respectively, and ON/OFF of the fixed electrical potential difference VDD1 for bias are controllable alternatively. If Switch SW becomes off, the impression of the fixed electrical potential difference VDD1 to a buffer is intercepted, and while a buffer suspends actuation, a bias current will not flow nearly completely. A display panel 3 is LCD of for example, a active-matrix mold, and is equipped with the pixel by which matrix arrangement was carried out. A display panel 3 specifies the gradation assigned for every pixel based on the digital picture signal (D0, D1, D2, D3) supplied from the picture signal supply means 1. Furthermore, the reference voltage (V0-V15) corresponding to the specified gradation is impressed to each pixel, and a display is copied out. The picture signal supply means 1 is equipped with gray scale conversion / buffer control circuit 12 as a description matter. This gray scale conversion / buffer control circuit 12 suspend actuation of the buffer corresponding to the gradation which controlled the reference voltage supply means 2 and was excluded while it drops the number of gradation of a digital picture signal according to the contents of the display and supplies it to a display panel 3. The switches SW0-SW15 attached in each buffer are specifically turned on/off controlled alternatively, and each buffer is switched between operating state and non-operating state. Thus, the indicating equipment concerning this invention controls actuation / un-operating accommodative depending on the contents of the signal input. [of a buffer] In addition, with this operation gestalt, gray scale conversion / buffer control circuit 12 is operating according to Vertical Synchronizing signal VSYNC inputted from the outside, and is performing gray scale conversion and buffer control for every frame.

[0010] When the contents of the display present change of comparatively simple gradation, he is trying to drop gradation, while the picture signal supply means 1 maintains the many gradation set up in first stage, when presenting change of gradation with the contents of the display it is desirable and comparatively complicated. Thereby, an accommodative setup of gradation is attained, without degrading image quality substantially. It becomes possible to reduce a part for the power which consumed the stopped buffer by changing into the gradation of an option specifically fewer than the default gradation initialized according to the input signal, and stopping completely the buffer of the gradation which is not used. In the system of this operation gestalt, 16 gradation is set up as a default. Moreover, 8 gradation is set up as an option. For example, 8 gradation can be set up every other gradation of 16 gradation. 4 gradation is also set up as other options. For example, what is necessary is just to set up 4 gradation every 3 of 16 gradation gradation. The gradation distribution for every screen is analyzed, and the input signal of 16 gradation is changed and displayed on 8 gradation or 4 gradation according to the result. In addition, gray scale conversion may choose either of the gradation of an option manually depending on the case, although a system is able to analyze the contents of a display and to carry out automatically.

[0011] For example, when a note type personal computer is used as a word processor, as for the image displayed on a display panel 3, 2 monochrome gradation occupies the greater part of whole screen. In the conventional system, even when such an input signal is generated by application, the buffer corresponding to all reference voltages is operating, and unnecessary power is consumed. When an input signal contains many 2 monochrome gradation in view of this point in the system in which for example, 16 gradation expressions are possible by this invention, the buffer for reference voltages of the 12 remaining gradation which is un-using it is completely suspended by changing display gradation into 4 gradation of an option from 16 default gradation. For example, a part for the power which the buffer corresponding to these SW(s) consumes can be reduced by turning off SW1-SW4, SW6-SW9, and SW11-SW14. When it puts in another way, only SW0, SW5, SW10, and SW15 become ON, and only the reference voltages V0, V5, V10, and V15 of 4 gradation will be supplied to a display panel 3.

[0012] Moreover, while the range where manifestation frequency is comparatively high maintains the gradation set up in first stage according to the gradation distribution showing the contents of the display, he is trying, as for the range where manifestation frequency is comparatively low, for the picture signal supply means 1 to drop gradation on this operation gestalt partially preferably. That is, parts for the power which consumed the stopped buffer are reduced by stopping completely the buffer of the gradation which deletes little gradation, and does not delete and use it relatively according to gradation distribution of an input signal. For example, when there is a signal input showing the landscape which includes "empty" as a visual field, the gradation by the side of white occupies the greater part of whole screen. In the conventional system, even when there is such a signal input, the buffer corresponding to all reference voltages is

operating, and unnecessary power is consumed. When an input signal contains many white side gradation with this operation gestalt in view of this point, for example in the system in which 16 gradation displays are possible as a default, 8 gradation by the side of white is displayed as a default setting, and the display gradation by the side of black is reduced from 8 default gradation to 2 gradation accommodative. For example, SW1-SW3, and SW5-SW7 are turned off alternatively. Thus, it is possible by making the whole into 10 gradation and suspending the buffer for the 6 remaining gradation to save a part for the power which consumed that stopped buffer. In addition, even if it drops 16 default gradation on 10 gradation, image quality is not lowered substantially.

[0013] Drawing 2 is the block diagram showing the concrete example of a configuration of a display panel 3 shown in drawing 1 . A display panel 3 is a active-matrix mold, and the gate line X and signal line Y which intersect the screen section mutually are arranged so that it may illustrate. Pixel PXL and the auxiliary capacity Cs are formed in the intersection of the gate line X of behavior, and the seriate signal line Y. Pixel PXL consists of counterelectrodes 39 which meet a pixel electrode and this, and electrooptic material, such as liquid crystal, is held between two electrodes. Each pixel PXL is driven by the thin film transistor Tr. The drain electrode of a thin film transistor Tr is connected to corresponding Pixel PXL and the corresponding auxiliary capacity Cs, a source electrode is connected to the corresponding signal line Y, and the gate electrode is connected to the corresponding gate line X. It connects with the V shift register 31, and the selection scan of each gate line X is carried out by line sequential. The thin film transistor Tr for a party linked to the selected gate line X is put on switch-on. Consequently, electrical connection of the pixel PXL for a party will be carried out to the signal line Y which corresponds, respectively.

[0014] The H shift register 32, an input line 33, a sampling switch 34, the bit register 35, the latch 36, the decoder 37, the reference voltage supply line 38, etc. are formed in the upper limit of the screen containing the pixel PXL by which the matrix array was carried out as the circumference drive circuit section. The H shift register 32 carries out sequential closing motion control of the sampling switch 34 used as 4 sets [1], samples the digital data (D0, D1, D2, D3) of 4 bit-parallel configurations supplied from the outside through the input line 33, and stores it in the corresponding bit register 35. When the sampling of the digital data corresponding to the pixel for a party is completed, the digital data stored in the bit register 35 are read to latch 36 all at once. Furthermore, a decoder 37 decodes the digital data stored in the latch 36, and specifies the reference voltage assigned for every pixel. A decoder 37 makes an ON state any one of the SW(s) connected to 16 output terminals, chooses the level as which the reference voltages V0-V15 supplied from the outside through the reference voltage supply line 38 were inner-specified, and supplies it to the corresponding signal line Y. Consequently, specific reference voltage will be written in Pixel PXL through a thin film transistor Tr.

[0015]

[Effect of the Invention] As explained above, while according to this invention dropping the number of gradation of a digital picture signal according to the contents of the display and supplying a display panel, actuation of the buffer corresponding to the gradation which controlled the reference voltage source of supply and was excluded is suspended. By adjusting the number of display gradation depending on an input signal, it becomes possible by making the buffer corresponding to unnecessary reference voltage into non-operating state, without degrading image quality substantially to attain low consumption output-ization of the whole system.

[Translation done.]